Clean Water Alliance

We are a diverse collection of citizens concerned about the health, environmental and economic impacts that proposed radioactive mining projects would have on our communities, people, and natural resources.

After much research and investigation, we are convinced uranium mining would have dire con-sequences. Our goal is to prevent uranium mining in the Black Hills region and to protect our valuable re-sources — especially our water — for future generations.

Uranium mining has been stopped before in the Black Hills.

We need to stop it now.

> ***Never doubt that a small group of thoughtful, committed citizens can change the world. Indeed, it is the only thing that ever has.***
>
> ***Margaret Mead***

How can I learn more about uranium mining in the Black Hills?

Go to our website: www.bhcleanwateralliance.org

Email us: nobhuranium@gmail.com

Write us:

Clean Water Alliance
P.O. Box 591
Rapid City, SD 47709

Stop Uranium Mining in the Black Hills

We are grateful to Coloradoans Against Resource Destruction, C.A.R.D. for permission to reprint this information.

12/15/12

Print front to back, fold in half for a 5.5 x 8.5 booklet

IN SITU LEACH URANIUM MINING AND WATER

WHAT DO WE KNOW?

Clean Water Alliance

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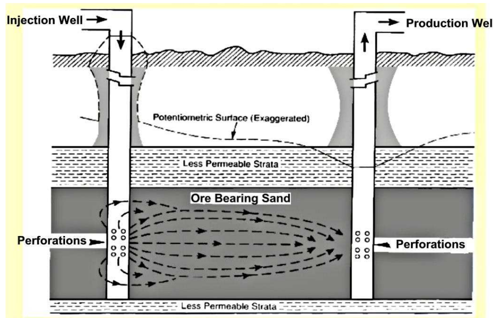
WHAT DO WE KNOW?



Generalized Diagram of Uranium ISL Mining Method

WHAT IS IN SITU LEACH MINING?

In situ leach mining (ISL) will only work when a uranium deposit is located in a groundwater aquifer. Basically, water is used as a mining tool.

Wells are drilled into a uranium ore deposit in a grid pattern. Water mixed with sodium bicarbonate concentrate and oxygen – called "lixiviant" -- is pumped down into the deposit and through the uranium ore. It leaches the uranium and other heavy metals out of the rock, so they can be pumped to the surface of the ground. At the surface, the uranium is removed from the solution for further processing.

The water is recharged with the leaching solution and re-injected into the deposit. This loop continues until most of the uranium has been removed. The wastes include radioactive byproducts, as well as the heavy metals that are found with the uranium. These often include arsenic, selenium, lead, and molybdenum.

In situ mining is also called "solution" mining. While the impacts of the process have not been thoroughly studied, the research does give some important information. This fact sheet is a summary of that research.

IMPACTS OF THE IN SITU LEACH MINING PROCESS

In situ mining involves injecting a mining solution into groundwater that is substantially different from that groundwater..

This chart shows the levels of various substances in groundwater before mining started at the Kingsville Dome mine in Texas, and it shows the level of those substances that is typical for an in situ mining solution.[1]

The pumping associated with in situ leach mining can change pre-mining groundwater flows.

Substance	In Pre-Mining Groundwater	In Typical Mining Solution
Uranium	From <0.001 to 3.75	80
Molybdenum	From 0.01 to 3.5	10
Chloride	From 138 to 443	600
Bicarbonate	From 95 to 505	800
Sulfate	From 13 to 557	1200
Calcium	From 5.2 to 34	400

During restoration at a small, pilot in situ mine in northern Colorado, the pumping caused a 17-foot drawdown in nearby wells. [2] There have also been reports of dropping well levels in South Dakota during uranium exploration, but they have not been conclusively linked to the exploration at this time.
At the Kingsville Dome mine in Kleberg County, Texas, groundwater flow was reversed. It originally flowed east. Now, according to information gathered from six wells, it flows northwest.[3]

Notes:

1. All units are in milligrams per liter except EC, which is micromhos per centimeter. George Rice. *Effects of URI's Kingsville Dome Mine on Groundwater Quality: Final Report*. Kleberg County URI Citizen Review Board, July 2006.
2. Kenneth S. Wade. *Uranium In Situ Solution Mining and Groundwater Quality at the Grover Test Site, Weld County, Colorado*. Department of Earth Resources, Colorado State University. 1981.
3. George Rice. See above.
4. W.P. Staub, N.E. Hinkle, R.E. Williams, F. Anastasi, J. Osiensky, and D. Rogness. *An Analysis of Excursions at Selected In Situ Uranium Mines in Wyoming and Texas*. U.S. Nuclear Regulatory Commission, 1986.
5. George Rice. See above.
6. Department of Environmental Quality, State of Wyoming. "Notice of Violation" issued to Power Resources, Inc. September 12, 2007.
7. Department of Environmental Quality, State of Wyoming. "Notice of Violation" issued to Power Resources, Inc. March 7, 2008.
8. Kenneth S. Wade. See above.
9. George Rice. See above.
10. Richard Blubaugh, Vice President for Health, Safety and Environment, Powertech Uranium Corp. Speech to Rotary Club. Fort Collins, CO. January 2, 2008.
11. Greg Harman. "Undermining South Texas." *San Antonio Current*. October 3, 2007.
12. Greg Harman. See above.
13. U.S. Environmental Protection Agency. *Guidance Document for the Area of Review Requirement*. 1985.
14. W.P. Staub, N.E. Hinkle, R.E. Williams, F. Anastasi, J. Osiensky, and D. Rogness. See above.
15. Daniel C. Reeder. *Groundwater Quality and Hydrogeochemistry of the Laramie-Fox Hills Aquifer in the Milton Reservoir Area, Weld County, Colorado*. Earth Resources Department, Colorado State University. 1993.
16. J.M. Boggs and A.M. Jenkins. *Analysis of Aquifer Tests Conducted at the Proposed Burdock Uranium Mine Site: Burdock, South Dakota*. Tennessee Valley Authority. 1980.
17. W.P. Staub, N.E. Hinkle, R.E. Willings, F. Anastasi, J. Osiensky, and D. Rogness. See above.
18. W.P. Staub, N.E. Hinkle, R.E. Williams, F. Anastasi, J. Osiensky, and D. Rogness. See above.
19. U.S. Environmental Protection Agency. See above.
20. W.P. Staub, N.E. Hinkle, R.E. Williams, F. Anastasi, J. Osiensky, and D. Rogness. See above.
21. George Rice. See above.
22. "Alpha" and "beta" are names for two kinds of radiation. "Gamma" is a third. Alpha and beta radiation have to be inhaled or ingested to harm people. Gamma radiation will go through skin. James Warner. *Finite Element 2-D Transport Model of Groundwater Restoration for In Situ Solution Mining of Uranium*. Civil Engineering Department, Colorado State University. 1981. Kenneth S. Wade. See above.
23. John Santos, Texas Commission on Environmental Quality. Quoted in Dan Kelley. "As uranium mines closed, state altered cleanup goals." *Corpus Christi Caller-Times*. November 5, 2006.
24. The italics are in the original document. Department of Environmental Quality, State of Wyoming. "Notice of Violation" issued to Power Resources, Inc. March 7, 2008.
25. Department of Environmental Quality, State of Wyoming. March 7, 2008. See above.
26. Dan Kelley. "As uranium mines closed, state altered cleanup goals." *Corpus Christi Caller-Times*. November 5, 2006.
27. George Rice. See above.
28. All values are in milligrams per liter. J.A. Davis and G.P. Curtis. *Consideration of Geochemical Issues in Groundwater Restoration at Uranium In-Situ Leach Mining Facilities*. U.S. Geological Survey/U.S. Nuclear Regulatory Commission. 2007.
29. J.A. Davis and G.P. Curtis. See above.
30. Dan Kelley. See above.
31. Harvey Curtis, J.D. Testimony to the Agriculture, Livestock and Natural Resources Committee, State House, Colorado General Assembly. January 30, 2008.
32. Dan Kelley. See above.
33. Department of Environmental Quality, State of Wyoming. March 7, 2008. See above.

In one mining area at the Kingsville Dome mine, the company's water restoration failed to meet state requirements for seven substances (uranium, chloride, calcium, bicarbonate, sulfate, molybdenum and electrical conductivity). In the second area where restoration was attempted, the results failed to meet state standards for eight substances (uranium, chloride, pH, electrical conductivity, calcium, bicarbonate, sulfate and molybdenum). Water can continue to move underground after a mine closes, threatening nearby wells. [27]

The water at a wellfield that went through the restoration process at the Highland mine still had significantly increased amounts of arsenic, iron, manganese, selenium, and uranium eight years after mining ended. The levels of these substances at various stages of the process and the state of Colorado's water standards were:

	Beginning of Mining 1987	**End of Mining 1991**	**Before Injection of Hydrogen Sulfide 1998**	**End of Restoration 1999**	**State of Colorado Water Quality Standard** (for comparison only)
Arsenic	0.001	0.001	0.1	0.3	0.01
Iron	0.05	0.05	1.32	1.3	0.3
Manganese	0.03	0.66	0.41	0.49	0.05
Selenium	0.001	0.990	0.160	0.070	0.05
Uranium	0.05	40.19	3.0	3.53	0.030

The water at a wellfield that went through five years of restoration at the Crow Butte mine in Nebraska still had increased alkalinity, arsenic, magnesium, Radium-226, uranium, and vanadium. The uranium level was more than 10 times as high as when mining started. Restoration continued for another 4 years before the site was considered stabilized. [29]

Bill Von Till of the Uranium Recovery Branch of the U.S. Nuclear Regulatory Commission, which regulates in situ uranium mining, said, "What the groundwater community has found over the years is that trying to achieve cleanup to background is virtually impossible." [30]

At a hearing of the Colorado House of Representatives' committee on Agriculture, Livestock and Natural Resources on January 30, 2008, the attorney for a uranium company agreed that full water restoration is "almost impossible." [31]

When a uranium company cannot clean up water at an in situ mine to the level promised in their permit, regulating agencies often "relax" the water restoration standard.

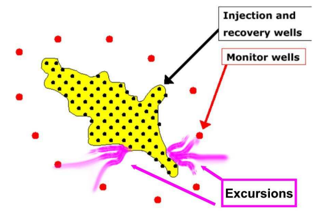
At 32 closed in situ mines in Texas, the state let companies leave behind higher levels of minerals than allowed by the companies' original permits, including uranium, molybdenum, and selenium. [32]

As at other types of uranium facilities, the bonds that are designed to insure clean-up at in situ mine sites can be inadequate due to the high costs of clean-up.

In March 2008, the State of Wyoming said this about the Smith Ranch and Highland in situ mines, run by Power Resources, Inc. (PRI): "Considering that reclamation will take several times longer, require at least twice the staff with higher wages and require much greater investments in infrastructure than PRI has estimated, a realistic reclamation cost estimate for this site would likely be on the order of $150 million, as compared to PRI's current calculation of $38,772,800. PRI is presently bonded for a total of only $38,416.500… Clearly the public is not protected." [33]

There are many examples of leaks and spills at in situ leach mining sites.

"One of the major problems associated with the in situ mining method is the uncontrolled migration of lixiviant and dissolved constituents such as radionuclides, arsenic, selenium, chromium and lead outside of the production zone. These undesirable lixiviant migrations are known as excursions." [4]



Depending on the definition, leaks from mining areas may or may not be counted as "excursions." The definition used by a uranium company at the Kingsville Dome mine meant that only two monitoring wells were considered "on excursion." Using a definition based on pre-mining water quality, 15 monitoring wells would have been considered "on excursion." [5]

Leaks at in situ leach operations can cause impacts on the surface. According to the Wyoming Department of Environmental Quality, in June 2007 there was a spill of 198,500 gallons of injection fluid at the Highland mine. After this spill was discovered, an additional spill of 3,747 gallons of production fluid was found. This resulted from a failed fitting and contained uranium and other minerals. About the same time, a valve was left open, allowing a discharge of five gallons per minute. This leak may have gone on for as long as 28 days before it was discovered. The spills flowed directly into the drainage of an ephemeral stream. [6]

Smith Ranch and Highland are in situ operations near Douglas, WY. In March 2008 the State of Wyoming said, "Over the years there have been an inordinate number of spills, leaks and other releases at this operation. Some 80 spills have been reported, in addition to numerous pond leaks, well casing failures and excursions. Unfortunately, if appears that such occurrences have become routine. The [Land Quality Division] currently has two three-ring binders full of spill reports from the Smith Ranch – Highland operations." [7]

For more information on leaks and spills at operating uranium mines in the United States, see: http://www.wise-uranium.org/umopusa.html

Monitoring wells must be spaced and set up correctly if they are going to detect leaks from the mining area.

The monitoring wells at a test site in northern Colorado were set up so that, at normal flow rates, water from the in situ mining area would not reach the monitoring wells for between 3 and 7-1/2 years. [8]

At the Kingsville Dome mine in Kleberg County, Texas, monitoring wells were set up so that leaks from the mining site were diluted before they could be measured. [9]

In situ leach mining uses large quantities of water.

A uranium company estimates that its proposed project in northern Colorado would use up (consume) between 864,000 gallons and 1,296,000 gallons of water per month. This is in addition to water that would be reused during the mining process. [10]

A proposed in situ mine in Goliad County, Texas, would "dispose" of over 2 million gallons of water per month. [11]

IMPACTS OF URANIUM EXPLORATION

Even before mining occurs, uranium exploration can cause problems.

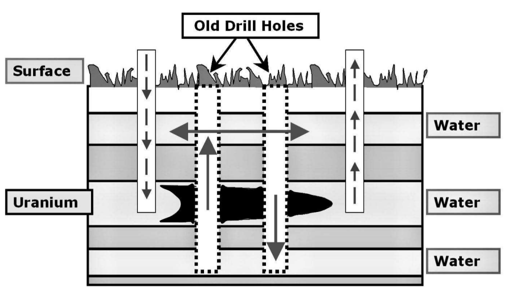
The Goliad County, TX., Commissioners have filed a lawsuit against a uranium company over problems that have occurred during exploration. These include water becoming undrinkable because of red sediment in wells and "extremely high" levels of radon-222 and radium-226. Well levels have changed. Exploration holes have been left unplugged, and radioactivity on the surface of the ground has increased because of drilling mud and wastes left by the company.[12]

The holes left by past drilling can let water move from one underground layer to another. This is called a "vertical leak." The presence of these holes can cause problems when in situ uranium mining pumps water into an aquifer under pressure.

Improperly plugged, completed, or abandoned wells that go through both a mining area and fresh water can provide a way for mining liquids to move into fresh water. Other links between drinking water and contaminate water can include fractures or faults in the underground rock.[13]

In a study of seven in situ mines in Wyoming and one in Texas, companies had a hard time keeping contaminated mining liquids from moving vertically. These liquids often moved up and down through old, unplugged exploration holes. This was particularly a concern when contaminated water from a mining area moved upward and threatened shallow aquifers that were used for drinking and agricultural purposes.[14]

Vertical Leaks



A study of water contamination in the Laramie-Fox Hills aquifer in northern Colorado showed that there were leaks from the upper layer of an aquifer to lower levels of the aquifer as a result of improper well abandonment. As a result, the water in the lower levels had become contaminated.[15]

In South Dakota, a study was done to determine water movement in an area that held uranium deposits. In this case, water from a uranium-bearing layer was pushing up into an aquifer above it due to artesian pressure. The authors believed that the water was moving through old unplugged uranium exploration holes. Water was also moving through a shale rock layer that separated the two aquifers because of "joints and fractures" in the shale. [16]

At a mine in Texas, 45 of the 120 wells that were drilled to see if mining solution was contaminating water outside the mining area showed leakage. This leakage was related to old exploration holes and occurred "for extended periods of time." Attempts to halt the spread of contaminants in a shallow aquifer by pumping fresh water into it, while pumping contaminated water out, "were apparently ineffective." [17]

Old exploration holes are very hard to locate.

"Older exploration holes in search of fossil fuels and uranium are difficult, if not impossible, to locate and many of them were improperly plugged and abandoned." "Older holes are most likely to be unplugged. However, they are difficult to locate because of the lack of records, the scattering and covering of well cuttings by erosion and vegetation, respectively, and the collapse of exposed surface casing, if indeed permanent casings were ever installed." [18] Casings are metal, plastic, or cement tubes used to seal a well off from the surrounding environment.

Locating abandoned wells can be difficult because this "includes wells that were drilled, completed and abandoned before adequate record keeping systems were established… Identifying problem wells that may provide a pathway for contaminants can be a major problem to deal with when adequate information on these wells is not available." [19]

Gaps and fractures in the rock that could allow contamination to leak from underground mine sites cannot always be predicted.

Underground structures and rock layers are complex. People tend to assume that a rock layer is consistent from one exploration hole to the next -- even when it isn't. Small changes in the physical characteristics of the rock ("slight variations in silt, clay or carbonate cementing agents") can produce large changes in how liquids move underground. [20]

IN SITU LEACH MINING RECLAMATION

In situ mining has been known to contaminate well water that was used by humans and livestock so that it can no longer be used for drinking.

Out of 16 wells tested before mining began at the Kingsville Dome in situ mine in Texas, one was suitable for use as a source of drinking, livestock or irrigation water. Restoration efforts did not return the well to its pre-mining quality. Uranium and molybdenum exceeded pre-mining levels by more than 150 times and more than 15 times, respectively. Now, the well can't be used for drinking water for humans or livestock. [21]

There are numerous examples of places where water has not been returned to its original use or quality after in situ leach mining ended.

The water quality problems that follow in situ operations have been known for years. In the late 1970s at a pilot in situ site near Grover, CO., water was tested before mining, when the mine closed, and three months later. When the mine closed, the state said the site was okay. Three months later, water at three wells showed significant increases in radioactive materials, nitrate, molybdenum, selenium, ammonia, and other contaminants. There was a 10-fold increase in "alpha" radiation, an 8-fold increase in radium-226, and a 3-fold increase in "beta" radiation. [22] This indicated that contamination was still moving around in the aquifer after mining and restoration were supposedly completed.

The State of Texas' Commission on Environmental Quality examined 32 closed in situ mine sites. The water was not returned to its original condition at any of them. [23]

The State of Wyoming issued a Notice of Violation for the Smith Ranch mine that included a site that had been in restoration for ten years. The notice said, "The 2007 Annual Report states that the ground water quality is similar to the '*end of mining*' wellfield conditions." [24] In the same Notice of Violation, the State said the permit for the Highland mine states that it usually takes "three years for uranium production, and three years for aquifer restoration." So far, the actual times for production and restoration had been two to three times longer than that. [25]

In a federal lawsuit in Texas, the court ruled that certain water wells had been used for drinking before ISL mining started. In their affidavits, ranchers who were suing a mining company said that the company had left uranium and selenium in the water, impacting ranching and hunting uses. The ranchers said that the mining company promised that the water would be returned to its pre-mining condition. [26]